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NATIONAL DAM SAFETY PROGRAM. ZANDER LAKE DAM (MO 10593), MISSOU--ETC(U)  
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**MISSOURI - KANSAS CITY RIVER BASIN**

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ZANDER LAKE DAM  
MONTGOMERY COUNTY, MISSOURI  
MO. 10593

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⑥ **PHASE I INSPECTION REPORT**  
**NATIONAL DAM SAFETY PROGRAM.**

Zander Lake Dam (MO 10593),  
Missouri - Kansas City River Basin,  
Montgomery County, Missouri. Phase I  
Inspection Report.

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**United States Army**  
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(15) DACW43-80-C-0094

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W. H. G. / Shier

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. <i>AD A125014</i>	3. RECIPIENT'S CATALOG NUMBER
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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REPORT TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
**ST. LOUIS DISTRICT, CORPS OF ENGINEERS**  
210 TUCKER BOULEVARD, NORTH  
ST. LOUIS, MISSOURI 63166

SUBJECT: Zander Lake Dam (Mo. 10593) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Zander Lake Dam (Mo. 10593).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure
- 3) Dam failure significantly increases the hazard to loss of life downstream

**SIGNED**

SUBMITTED BY: \_\_\_\_\_  
Chief, Engineering Division

**15 OCT 1980**  
Date

**SIGNED**

APPROVED BY: \_\_\_\_\_  
Colonel, CE, District Engineer

**15 OCT 1980**

Date

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ZANDER LAKE DAM  
MONTGOMERY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10593

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

PREPARED BY  
CONSOER, TOWNSEND AND ASSOCIATES, LTD.  
ST. LOUIS, MISSOURI  
AND  
PRC ENGINEERING CONSULTANTS, INC.  
ENGLEWOOD, COLORADO  
A JOINT VENTURE

UNDER DIRECTION OF  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS  
FOR  
GOVERNOR OF MISSOURI

SEPTEMBER 1980

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Zander Lake Dam, Missouri Inv. No. 10593  
State Located: Missouri  
County Located: Montgomery  
Stream: An unnamed tributary of the Scratchers Branch  
of the Little Loutre Creek  
Date of Inspection: June 6, 1980

Assessment of General Condition

Zander Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and PRC Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the U. S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property damage could occur in the event of failure of the dam. Within the estimated damage zone of four miles downstream of the dam are four dwellings, and two sheds, which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. However, the hazard classification is questionable for this dam due to the fact that the dwellings mentioned above do exist along the estimated downstream damage zone but it is unknown whether the dwellings do indeed lay in the estimated damage zone. To determine the actual damage zone would require a combined breach and flood routing analysis which is beyond the scope of a Phase I inspection. Zander Lake Dam is in the small size classification since it is less than 40 feet in height and impounds less

than 1,000 acre-feet of water.

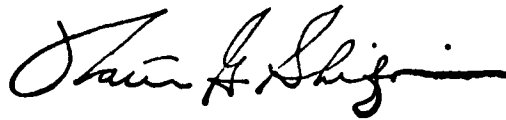
Our inspection and evaluation indicates that the spillway of Zander Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Zander Lake Dam being a small size dam with a high hazard potential is required by the guidelines to be able to pass from one-half of the Probable Maximum Flood (PMF) to the Probable Maximum Flood without overtopping the dam. Considering the questionable downstream damage zone the one-half of the PMF is considered the appropriate spillway design flood for Zander Lake Dam. It was determined that the reservoir/spillway system can accommodate approximately 45 percent of the Probable Maximum Flood before overtopping of the dam occurs. Our evaluation also indicates that the reservoir/spillway system will accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

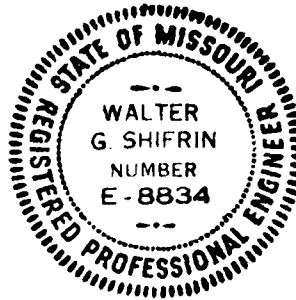
Zander Lake Dam and its appurtenant structures appeared to be in fair condition. However, some deficiencies were noted by the inspection team which could affect the safety of the dam and appurtenant structures. These items are as follows: the wave erosion on the upstream slope; the evidence of the rodent activity on the embankment; the small saplings, bushes, and tall vegetation on the embankment; the piles of gravel, bales of hay, reeds, and unmaintained vegetation in the spillway discharge channel; a need for periodic inspection by a qualified engineer; and a lack of a maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

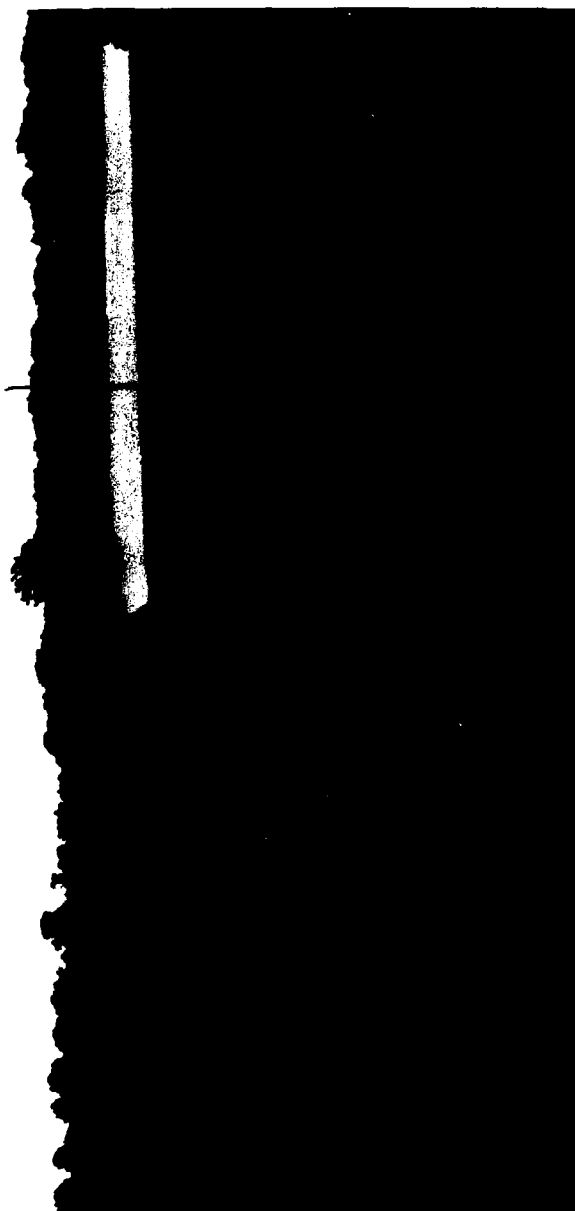


It is recommended that the owner take action to correct or control the deficiencies described above.



Walter G. Shifrin, P.E.





Overview of Zander Lake Dam

NATIONAL DAM SAFETY PROGRAM

ZANDER LAKE DAM, I.D. No. 10593

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

ZANDER LAKE DAM, Missouri Inv. No. 10593

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Zander Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Zander Lake Dam was made on June 6, 1980. The purpose of the inspection was to make a general assessment regarding the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, provides a summary of visual observations made during the field inspection, gives an assessment of hydrologic and hydraulic conditions at the site, presents an evaluation of the

structural adequacy of the various project features and appraises the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted in this report that reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the west abutment or side, and right abutment or right side to the east abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase I Dam Inspections.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Robert Starr, the contractor who designed and constructed the dam. No design drawings for the dam or appurtenant structures were available.

The dam is a homogeneous, rolled, earthfill structure with a straight alignment between earth abutments. Photos 1 through 3 show views of the embankment. The dam has an axis length of 560 feet between the spillway and the right abutment. The top width

varies from 7 to 10 feet. The top of dam varies in elevation. From the emergency spillway at the left side of the embankment, the top of dam slopes upward to a point approximately 160 feet to the right of the right edge of the spillway with an elevation gain of 1.1 feet. From this point, the top of dam is level for a distance of 280 feet to a point 120 feet from the right abutment; then for the last 120 feet the top of dam slopes upward to the right abutment with a rise in elevation of 1.0 foot (see Plate 2). The minimum elevation of the top of dam is approximately 770.4 feet above mean sea level (M.S.L.). The maximum structural height of the dam was measured to be 17.5 feet. The upstream slope above the water surface was measured as 1 vertical to 3 horizontal (1V to 3H). The downstream slope was also measured to be 1V to 3H. A 12- to 13-foot wide core trench was excavated parallel to the dam axis, according to Mr. Starr.

The dam was constructed with only one spillway which operates as an open channel. When measured at the axis of the dam, it is a trapezoidal channel with a 30-foot bottom width, an 88-foot top width, and side slopes of about 1V to 8H on the left and approximately 1V to 18H on the right. It is cut into the left abutment and its crest elevation is 768 feet above M.S.L. (assumed), which places it 2.4 feet lower than the minimum top of dam. After passing the crest, which is level for a distance of 14 feet, excess water flows into a discharge channel which has a slope of 5 to 6 percent and a cross section which is generally a wide swale (see Photo 7). The discharge channel directs flows away from the dam parallel to a county road before generally curving to the right and into the downstream channel. There is a 4-foot drop over which water flows from the discharge channel into the downstream channel. The discharge channel generally does not have any real definition to it; i.e., it seems that the flow would meander from the area of the crest to the downstream channel.



No low level outlets or outlet works were provided for this dam.

b. Location

Zander Lake Dam is located in Montgomery County of the State of Missouri on an unnamed tributary of the Scratchers Branch of the Little Loutre Creek. The dam is located approximately 3 miles northwest of Montgomery City in the northeast corner of Section 22 of Range 6 West, Township 49 North as shown on the Wellsville, Missouri Quadrangle (7.5 minute series) sheet.

c. Size Classification

Zander Lake Dam impounds less than 1000 acre-feet but more than 50 acre-feet which classifies it as a "small" dam. The maximum structural height is less than 25 feet which is the minimum height requirement for a structure to be classified as a dam. Nevertheless, the size classification is determined by either the storage or the height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category according to the "Engineer Regulation No. 1110-2-106, Appendix D" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Based upon a visual inspection of the downstream area there are four dwellings and two sheds located along the estimated damage zone, which extends approximately four miles downstream of the dam (see Photos 11 and 12). However, it is questionable whether or not the dwellings mentioned above do indeed

lay within the estimated damage zone. To determine the actual damage zone would require a combined breach and flooding routing analysis which is beyond the scope of a Phase I inspection.

e. Ownership

Zander Lake Dam is owned privately by Mr. Richard Zander. The mailing address is as follows: Mr. Richard A. Zander, 219 First Capital Plaza, St. Charles, Missouri, 63301.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

Mr. Robert Starr of Montgomery City, Missouri designed and constructed Zander Lake Dam in 1968. Mr. Starr was the owner of the property when the dam was constructed. The dam was built without plans and specifications.

h. Normal Operational Procedures

Normal procedure is to allow the reservoir to remain as full as possible. The water level is controlled by rainfall, runoff, evaporation and the elevation of the spillway crest.

1.3 Pertinent Data

a. Drainage Area (square miles):. . . . . 0.18

b. Discharge at Damsite

Estimated experienced maximum flood (cfs):. . . . . Unknown

Estimated ungated spillway capacity with  
reservoir at minimum top of dam elevation (cfs):. . . . 600

c. Elevation (Feet above MSL)

Top of dam (minimum):. . . . . 770.4

Spillway crest:. . . . . 768.0 (Assumed)

Normal Pool: . . . . . 768.0

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: . . . . . 768.0

d. Reservoir

Length of pool with water surface  
at top of dam elevation (feet):. . . . . 1400

e. Storage (Acre-Feet)

Top of dam (minimum):. . . . . 81

Spillway crest:. . . . . 59

Normal Pool: . . . . . 59

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: . . . . . 59

f. Reservoir Surfaces (Acres)

Top of dam (minimum):. . . . . 10

Spillway crest:. . . . . 8.5

Normal Pool: . . . . . 8.5

Maximum Experienced Pool:. . . . . Unknown

Observed Pool: . . . . . 8.5

g. Dam

Type:	Rolled, Earthfill
Length:	560 feet (excluding the spillway)
Structural Height:	17.5 feet
Hydraulic Height:	17.5 feet
Top width:	Varies 7 to 10 feet
Side slopes:	
Downstream	1V to 3H
Upstream	1V to 3H (Above the water surface)
Zoning:	Homogeneous
Impervious core:	NA
Cutoff:	A core trench with a bottom width of 12 to 13 feet (According to Mr. Starr)
Grout curtain:	None
Volume:	15,500 cu.yds. (estimated)

#### h. Diversion and Regulating Tunnel. . . . None

i. Spillway

```

Type: . . . . . Earthcut channel, uncontrolled
Bottom width: . . . . . 30 feet
Crest Elevation (feet above MSL): . . . 768.0 feet

```

j. Regulating Outlets . . . None

## SECTION 2: ENGINEERING DATA

### 2.1 Design

Design drawings and calculations are not available for this dam.

### 2.2 Construction

No data are available concerning the construction of the dam and appurtenant structures, other than the information obtained from Mr. Starr given below.

According to Mr. Starr, the compaction of the embankment was achieved by the activity of the earthmoving equipment across the embankment and no compaction control was employed. A core trench was excavated parallel to the dam axis but not to bedrock. The trench had a bottom width of 12 to 13 feet and near vertical side slopes. A dragline was used to remove saturated sand, which was encountered at the damsite, so that a suitable foundation for the embankment could be established. The depth of saturated sand varied in depth from 2 to 8 feet. The sand was stockpiled and mixed with the clay material used in the embankment. The clay used for the embankment was removed from the reservoir rim.

### 2.3 Operation

No operational records are available for Zander Lake Dam.

## 2.4

### Evaluation

#### a. Availability

No design drawings, design computations, construction data, or operation data are available. The engineering data used in this report was obtained from the Soil Survey of Montgomery County conducted by the Soil Conservation Service, State Geological Maps, and U.S.G.S. Quadrangle Sheets.

#### b. Adequacy

The available engineering data was not sufficient for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation, and construction data, but is based primarily on visual inspection and past performance. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

#### c. Validity

No valid engineering data pertaining to the design or construction of the dam and appurtenant structure were available.

### SECTION 3: VISUAL INSPECTION

#### 3.1 Findings

##### a. General

A visual inspection of the Zander Lake Dam was made on June 6, 1980. The following persons were present during the inspection:

<u>Name</u>	<u>Affiliation</u>	<u>Disciplines</u>
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Project Engineer, Soils and Mechanical
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
Robert McLaughlin, P.E.	PRC Engineering Consultants, Inc.	Civil
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
John Lauth, P.E.	Consoer, Townsend & Assoc., Ltd.	Civil and Structural

Specific observations are discussed below.

b. Dam

The overall condition of the dam appears to be fair. Some items of concern were observed and are described below.

The top of dam is adequately protected against surface erosion by an unmaintained vegetative cover (see Photo 2). A comprehensive inspection of the top of dam was hampered due to the vegetative cover. No depressions or cracks indicative of an instability of the embankment were apparent. The difference in elevation along the top of dam did not appear to be due to an instability of the embankment. The dam was most likely constructed in this manner. No misalignments in either the vertical or horizontal direction, other than the difference in elevation along the axis, were apparent. Piles of cobbles were observed on the top of dam in a few places. No evidence indicating that the dam has ever been overtopped was observed.

The upstream slope has no riprap protection and consequently, considerable damage to the slope has occurred due to wave action (see Photos 1 and 4). Erosional scarps, undercutting, and areas with small tension cracks, where sloughing is likely to take place in the future, were observed along the slope (see Photo 4). Cattails were observed growing along the shoreline in some areas. The cattails actually appear to provide some protection against wave erosion for the slope. The upper portion of the slope appeared to be adequately protected against surface erosion by an unmaintained grass cover. A comprehensive inspection of the slope was hampered due to the height of the vegetative cover. Evidence of burrowing animals was observed on the slope. No depressions, bulges or cracks indicative of major slope or foundation movement were apparent. One small sapling was found growing on the slope near the spillway.



The downstream slope is adequately protected against surface erosion by an unmaintained vegetative cover (see Photo 3). A comprehensive inspection of the slope was hampered due to the height of the vegetation. No depressions, bulges or cracks indicative of major slope or foundation movement were apparent. No seepage on the embankment or at the toe was observed. Small animal holes up to 1 inch in diameter were observed on the slope and near the toe of the slope (see Photo 5). One small sapling and some small bushes were observed on the slope.

Both abutments slope gently upward from the crest. No instabilities, seepage or erosion were observed on either abutment.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of the Scratchers Branch of the Little Loutre Creek in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosional cycle.

The topography at the damsite is flat to rolling on the east, and hilly on the west with V-shaped valleys. Elevation of the ground surface ranges from 780 feet above M.S.L. at the damsite to 849 feet above M.S.L. nearly 2.5 miles northeast of the damsite. The reservoir slopes are in the range of 5° to 10° from the horizontal. The area near the damsite is covered with slope wash deposits of glacial-fluvial and loess origins consisting of reddish brown, silty clay.

The regional bedrock geology beneath the glacial outwash deposits in the damsite area, as shown on Geologic Map of Missouri (1979) (see Plate 4), consists of the Pennsylvanian Marmaton-Cherokee Group (cyclic deposits of shale limestone and sandstone), the Mississippian age Burlington Limestone (cherty, grayish brown, sandy limestone), the Mississippian Chouteau Group, the Devonian Sulphur Springs Group (Bushberg Sandstone, Glen Park Limestone, Grassy Creek Shale), and the Ordovician rocks consisting of Maquoketa Shale, Kimmswick Limestone, Cape Limestone, Joachim Dolomite, St. Peter Sandstone, Smithville Formation and Powell Dolomite.

No outcropping of rock was noticeable at the damsite. The predominant bedrock near the site vicinity underlying the glacial-fluvial deposits are the Pennsylvanian Marmaton-Cherokee Group (cyclic deposits of shale, limestone and sandstone) and Mississippian Burlington Limestone. Inlet and outlet areas of this unnamed tributary of the Scratchers Branch exhibit quaternary alluvium.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault in the vicinity of the damsite is the Mineola Fault nearly 10 miles southeast of the damsite. The Mineola Fault had its last movement in post-Early Ordovician time. Thus, the fault has no effect on the damsite.

Zander Lake Dam consists of a homogeneous earthfill embankment, and a spillway located at the left abutment end of the embankment.

No boring logs or construction reports were available which would indicate foundation conditions encountered during the construction. Based on the visual inspection, the embankment probably rests on glacial-fluvial deposits (reddish brown, silty clay). The spillway was cut into the left abutment, which consists of glacial-fluvial deposits (reddish brown, silty clay).

## (2) Project Soils

According to the "Soil Survey of Montgomery and Warren Counties, Missouri" published by the Soil Conservation Service in 1978, the common soils in the general area of the dam belong to the Mexico-Armster-Putnam association. The soil at the damsite consists of the Armster loam, the Mexico silt loam and the Sharon silt loam. These soils are basically formed from glacial till, alluvium, and loess.

Materials removed from the upstream and downstream slopes of the embankment appeared to be a light brown, silty clay with traces of fine to medium sand. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This is an impervious soil type which generally has the following characteristics: a coefficient of permeability less than 1.0 foot per year, medium shear strength, and a high resistance to piping.

### d. Appurtenant Structures

#### (1) Spillway

According to Mr. Starr, areas of saturated sand were encountered at the damsite during the construction of the dam. This may be a contributing factor to the standing water found in the discharge channel (see Photo 8), which created sort of a marshy condition. There are also bales of hay and piles of gravel in the vicinity of the standing water and elsewhere in the discharge channel which were placed there to provide erosion protection. The entrance to the spillway has a growth of reeds which fairly well covers the entire width of the approach to the inlet (see Photo 6). Also, it was observed that a stand of grass 2 to 3 feet high covers most of the discharge channel area (see Photos 6 and 7). Then when the discharge channel intersects the downstream channel, it does so at an unfavorable angle of 90 degrees.

(2) Outlet Works

No low level outlets or outlet works were provided for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of the inspection was 768.0 feet above M.S.L.

The surface area of the reservoir at normal water level is about 8.5 acres. The rim appears to be stable with no severe erosional problems observed. Minor wave erosion and localized erosional scarps were observed along the shoreline. The land around the reservoir slopes gently to the rim and is grass and tree covered (see Photo 10). One home is built in close proximity to the reservoir.

f. Downstream Channel

The downstream channel is a well defined meandering channel. It is fairly narrow and shallow and is partially obstructed with trees. A fairly wide floodplain exists outside of the channel (see Photo 9). The hydraulic efficiency of the channel will be slightly affected by the trees.

3.2 Evaluation

The visual inspection uncovered nothing of a consequential nature which would require immediate remedial action. However, some conditions were observed which could adversely affect the dam and the spillway in the near future.

1. The wave erosion on the upstream slope does not appear to affect the stability of the dam in its present condition. Nevertheless, continual erosion of the slope which appears to be evident can only be detrimental to the stability of the dam.

2. The small animal activity observed on the embankment and near the toe could jeopardize the safety of the dam. The holes created by the animals make avenues for possible piping.

3. The small saplings and bushes on the embankment do not pose a danger to the safety of the dam at this time. Nevertheless, if the saplings are allowed to grow, they pose a potential danger to the safety of the dam. Depending upon the extent of the root systems of large trees, the roots could provide paths for piping through the embankment.

4. The present vegetation on the embankment should be properly maintained. A heavy growth of vegetation on the embankment hinders a comprehensive inspection of the dam and potential problems could go undetected.

5. The marshy condition does not appear to be detrimental to the flow characteristics of the spillway discharge channel. However, the hay bales and gravel piles would cause a certain amount of turbulence and the high grass would contribute to a reduced flow velocity in the discharge channel. The reeds growing at the entrance to the inlet would tend to retard the flow of excess reservoir water from the reservoir to the crest. The four foot drop at the end of the discharge channel is an earthen drop and, as such, is subject to erosion; however, this doesn't appear to pose a dangerous condition for the dam.

## SECTION 4: OPERATIONAL PROCEDURES

### 4.1 Procedures

No specific operational procedures are in effect for the dam. The water level below the spillway crest is allowed to remain as high as possible. The water level is controlled by rainfall, runoff, evaporation and unregulated spillway releases.

### 4.2 Maintenance of Dam

The dam is maintained by the owner, Mr. Richard Zander. The dam embankment appears to have received very little maintenance and upkeep. The entire embankment is covered with a dense growth of vegetation and a few saplings and small bushes were observed on the upstream and downstream slopes. Dumped rock and bales of hay were placed in the spillway several years ago to prevent erosion of the spillway. There have been no major repairs done to the dam itself since its original construction.

### 4.3 Maintenance of Operating Facilities

There are no operating facilities associated with Zander Lake Dam.

### 4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system consisting of any electrical warning systems or manual warning notification plans in effect for this dam.

4.5      Evaluation

Operational procedures are nonexistent, and the maintenance at Zander Lake Dam appears to be inadequate at this time. The remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

#### a. Design Data

The watershed area of the Zander Lake Dam upstream from the dam axis consists of approximately 113 acres. The watershed is pasture and range land with some wooded areas. Land gradients in the watershed average roughly 3 percent. The Zander Lake Dam is located on an unnamed tributary of the Scratchers Branch of the Little Loutre Creek. The reservoir behind the dam is about 0.5 miles upstream from the confluence of the unnamed tributary and the Scratchers Branch. The watershed at its longest arm is approximately 0.6 miles long. A drainage map showing the watershed and the downstream hazard zone is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Zander Lake Dam was based on criteria set forth in the Corps of Engineers' "Engineer Regulation No. 1110-2-106" and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in the Corps of Engineers' EM 1110-2-1411 (Standard Project Storm). The Soil Conservation Service (SCS) method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The unit hydrograph parameters are presented in Appendix B. The SCS method was also used for determining the loss rate. The hydrologic soil group of the watershed was determined by the use of published soil maps. The hydrologic soil group of the watershed and the SCS curve number are presented in Appendix



B. The curve number, the unit hydrograph parameters, the PMP index rainfall and the percentages for various durations were direct input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak inflow discharges of the PMF and the one-half PMF are 2,212 cfs and 1,106 cfs, respectively.

Both the PMF and the one-half PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. An antecedent storm of 50 percent of the PMF preceded the PMF and the an antecedent storm of 25 percent of the PMF preceded the one-half PMF, each by four days. The starting elevation for routing antecedent floods was assumed to be equal to the mean annual high water level in the reservoir. The mean annual high water level for Zander Lake Dam reservoir was estimated to be at the crest of the spillway. The water level in the reservoir at the end of the four day routing period was at the same elevation as the crest of the spillway. The reservoir was assumed at this level at the start of the routing computation for the PMF and the one-half PMF. The peak outflow discharges for the PMF and the one-half PMF are 1,722 and 710 cfs, respectively. Both the PMF and the the one-half PMF when routed through the reservoir resulted in overtopping of the dam.

The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were taken from field notes and sketches, prepared during the field inspection. The reservoir stage-capacity data were based on the U.S.G.S. Wellsville, Missouri Quadrangle topographic map (7.5 minute series). The reservoir elevation-area curve and the spillway and overtop rating curve are presented in Plates 2 and 3, respectively, in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erosive characteristics. The safe hydrologic design of an embankment dam requires a

spillway discharge capability combined with an embankment height that can handle a very large and exceedingly rare flood without overtopping the dam.

The Corps of Engineers designs dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life. However, since the high hazard classification for the downstream hazard zone is questionable, the hydrologic requirement for safety for this dam is the capability to pass one-half of the Probable Maximum Flood without overtopping the dam.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. Nevertheless, there was no evidence of the dam ever having been overtopped.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1.a, both the Probable Maximum Flood and the one-half Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and the one-half PMF are 1,722 and 710 cfs, respectively. The capacity of the spillway is 600 cfs. The PMF overtopped the top of dam by 1.27 feet and one-half of the PMF overtopped the dam by 0.21 feet. The total duration of flow over the top of dam is 0.83 hours during the PMF and 0.33 hours during

the one-half PMF. The spillway and downstream slope of the embankment may be susceptible to erosion due to the high velocity of flow during overtopping of the dam. The spillway/reservoir system of Zander Lake Dam is capable of accommodating a flood equal to approximately 45 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Zander Lake Dam will accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately four miles downstream of the dam. There are four dwellings and two sheds which are probably located within the damage zone.

## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

#### a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The erosion due to wave action on the upstream slope does not endanger the structural integrity of the embankment in its present condition. Nevertheless, if the erosion continues, it can only have an adverse effect on the stability of the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The structural stability of the crest and discharge channel of the spillway appeared to be adequate on the day of the inspection.

#### b. Design and Construction Data

No design computations pertaining to the embankment or appurtenant structure were uncovered. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structure. The water level on the day of inspection was at the crest of the spillway, and it is assumed that the reservoir remains close to full at all times. No regulated outlet works or low level outlets were provided for this dam.

d. Post Construction Changes

No post construction changes to the embankment are known to exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1 (see Plate 6), as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude which would be expected in Seismic Zone 1 will not cause significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite.

## SECTION 7: ASSESSMENT/REMEDIAL MEASURES

### 7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation, however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external factors, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be an assurance that an unsafe condition could be detected.

#### a. Safety

The spillway capacity of Zander Lake Dam is found to be "Inadequate". The spillway/reservoir system will accommodate about 45 percent of the PMF without overtopping the dam. The safety of the embankment will be in jeopardy if the dam is overtopped. The embankment itself would be susceptible to erosion due to the high velocity of flow on its downstream slope which could lead to an eventual failure of the dam.

The dam and appurtenant structures appeared to be in fair condition. However, no quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structure, however, appear to have performed satisfactorily since their construction without failure or evidence of instability. There was no evidence of the dam ever having been overtopped.

The safety of the dam can be improved if the deficiencies described in Sections 3 and 6.1a and below are properly corrected as described in Section 7.2b. The burrowing animals observed on the embankment could jeopardize the safety of the dam. The holes created by the animals make avenues for possible piping. The small saplings and bushes on the embankment do not affect the safety of the dam in their present condition, however, they could have an adverse effect on the dam if allowed to grow.

b. Adequacy of Information

Information relating to the design and construction of the dam is completely lacking. The conclusions presented in this report are based upon field measurement, past performance and present condition of the dam. Information on the design hydrology, hydraulic design, and the operation and maintenance of the dam were not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished in the near future. The items recommended in Paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and assuming that the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful aspects of such a failure. Some of these options are:

1. Increase the spillway capacity to pass the PMF without overtopping.
2. Increase the height of the dam enough to pass the PMF without overtopping the dam; an investigation should be done which also includes studying the effects on the structural stability of the existing emankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.
3. A combination of 1 and 2 above.

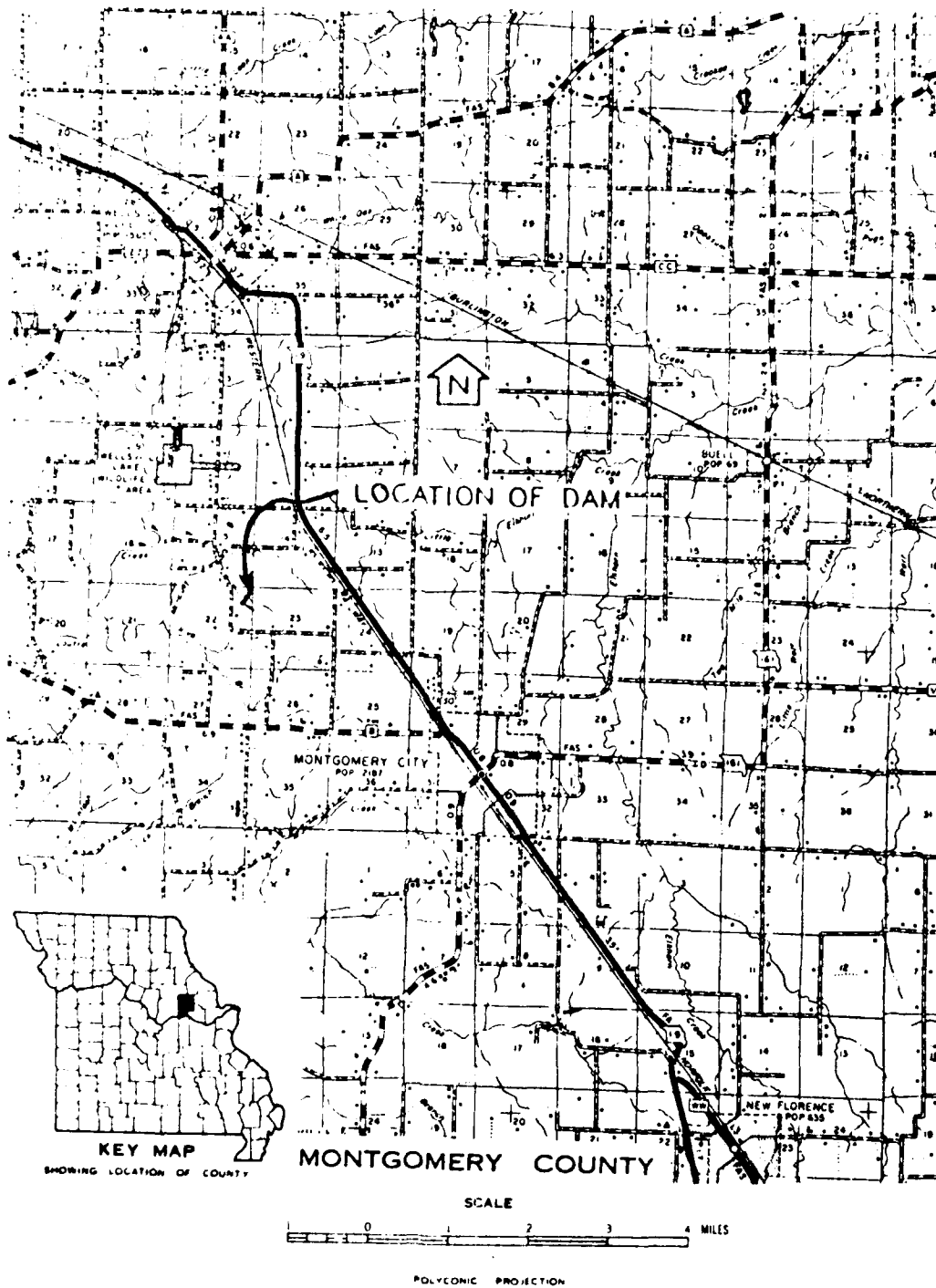


b. O & M Procedures

1. The erosion due to wave action on the upstream slope should be properly repaired and protected from further damage.
2. Determine the extent of damage done to the embankment by burrowing animals, if any, and make corrective repairs as required. All burrowing animals should be eliminated from the embankment and their burrows properly backfilled and compacted.
3. The small saplings and bushes should be removed from the embankment and prevented from regrowth.
4. The vegetation on the embankment should be maintained periodically and large vegetation, such as bushes and trees, should be prevented from growing on the slope.
5. The hay bales and piles of gravel in the spillway discharge channel should be either removed or spread around the adjacent areas within the channel.
6. The reeds in front of the spillway inlet area should be removed and maintained in such condition. Also, the grass within the spillway and discharge channel generally should be cut and maintained at a one foot maximum height.
7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.
8. The owner should initiate the following programs:

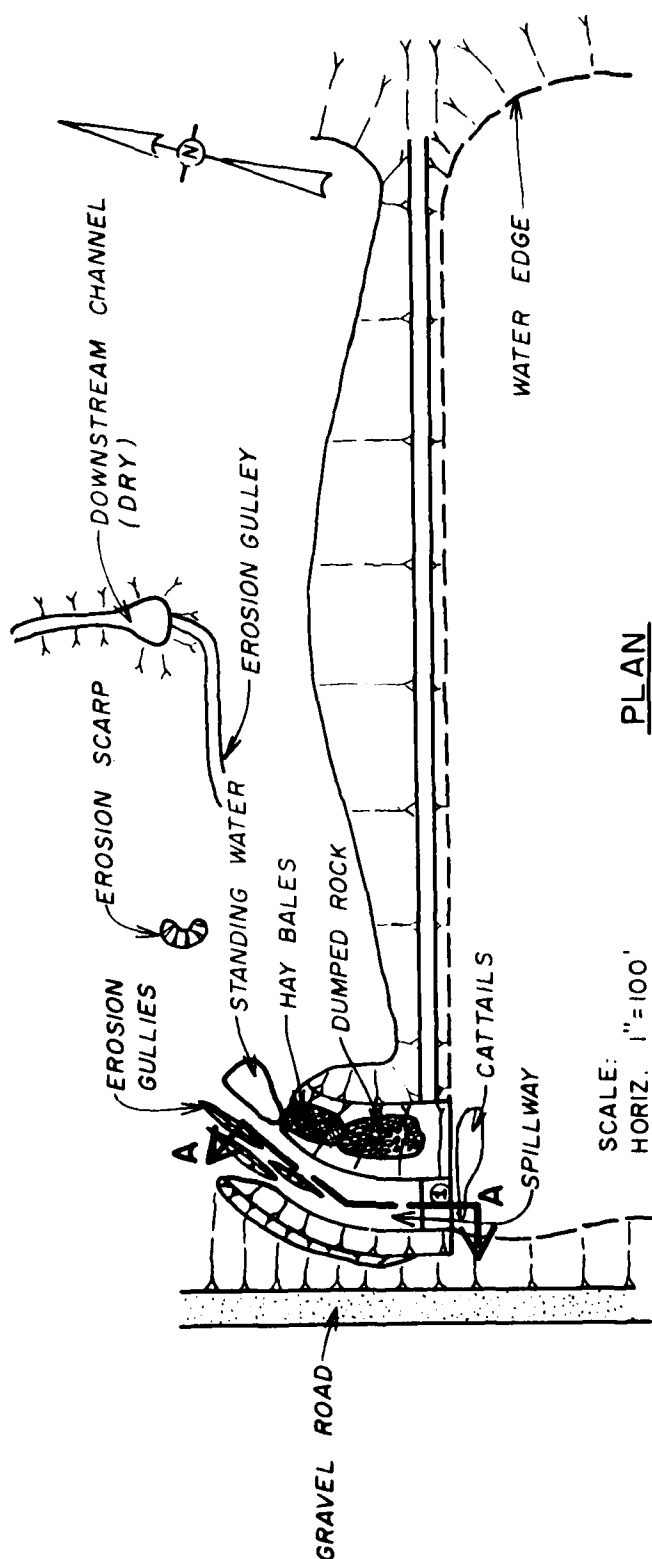
- (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.
- (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

PLATES



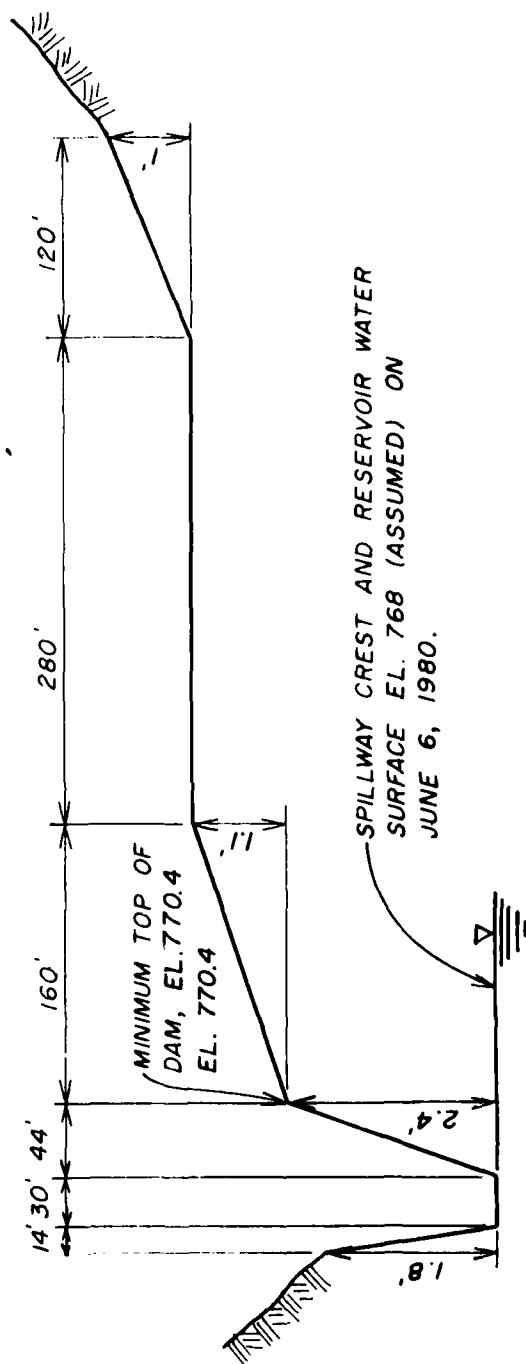
LOCATION MAP — ZANDER LAKE DAM

MO. 10593



PLAN

SCALE:  
HORIZ. 1"=100'



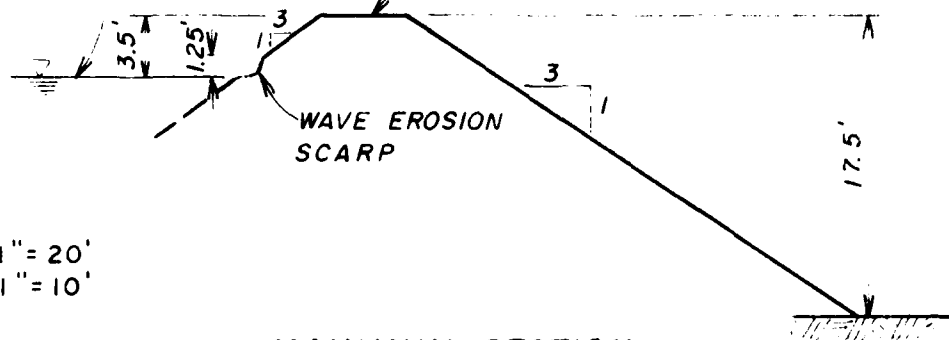
ELEVATION

SCALE:  
HORIZ. 1"=100'  
VERT. 1"=2'

SPILLWAY CREST AND  
RESERVOIR WATER  
SURFACE EL. 768  
ON JUNE 6, 1980

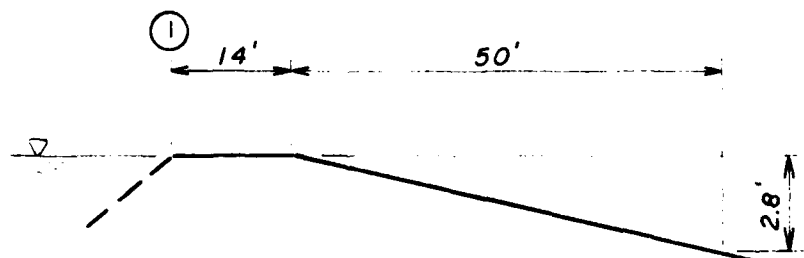
CREST WIDTH VARIES FROM 7' TO 10'

TOP OF DAM EL. 771.5 AT MAXIMUM SECTION



SCALE:  
HORIZ. 1" = 20'  
VERT. 1" = 10'

MAXIMUM SECTION

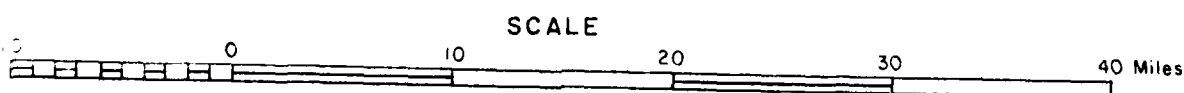


SCALE:  
HORIZ. 1" = 20'  
VERT. 1" = 5'

SECTION A-A  
SPILLWAY PROFILE

① REFERENCE POINT, SEE SHEET 1 OF 2

ZANDER LAKE DAM (MO. 10593)  
MAXIMUM SECTION OF EMBANKMENT AND  
SPILLWAY PROFILE  
(SHEET 2 OF 2)



⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 5

REFERENCE:

GEOLOGIC MAP OF MISSOURI  
DEPARTMENT OF NATURAL RESOURCES  
MISSOURI GEOLOGICAL SURVEY  
KENNETH H. ANDERSON, 1979

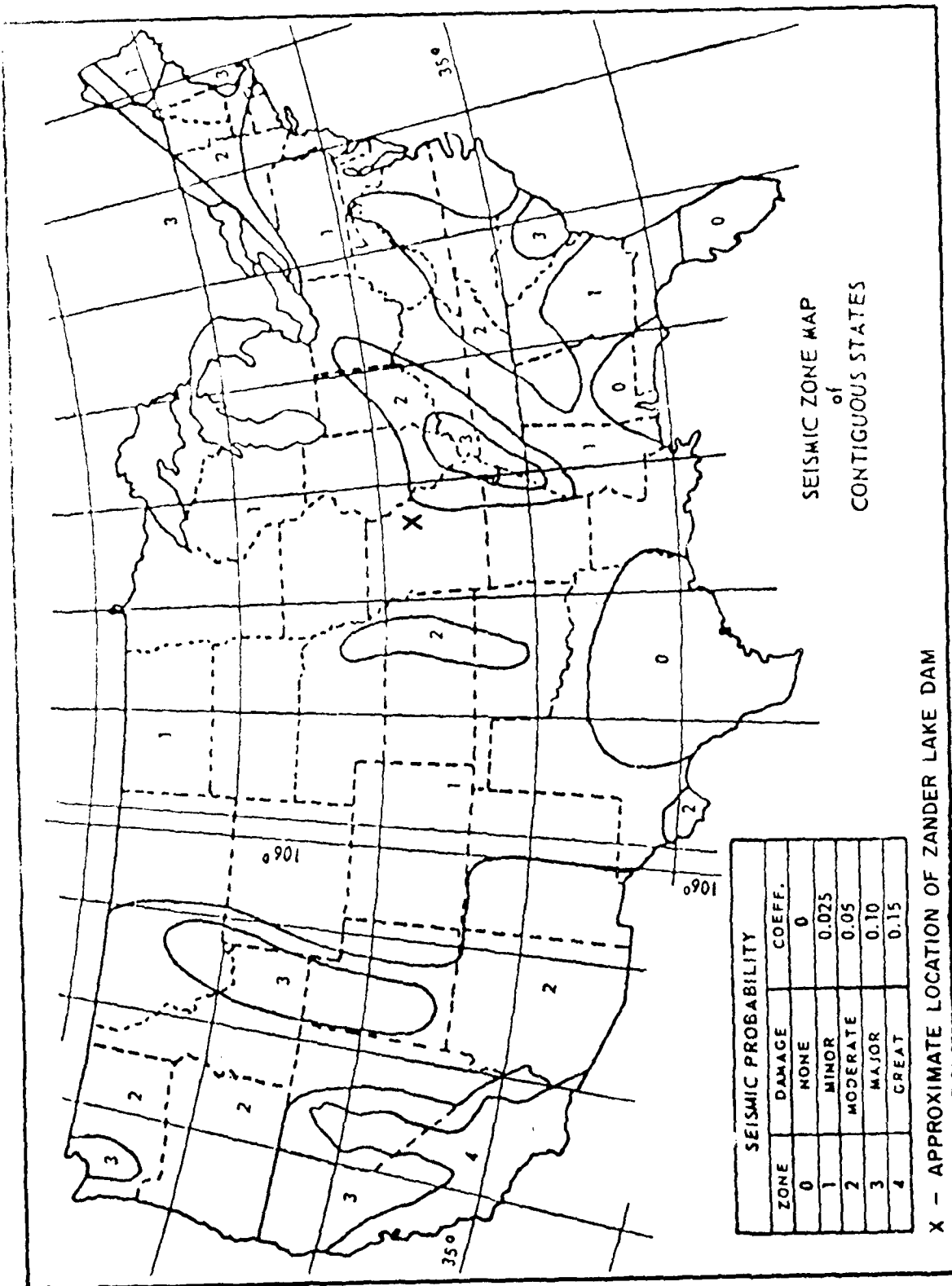
REGIONAL GEOLOGICAL MAP  
OF  
ZANDER LAKE DAM

ZANDER LAKE DAM  
PLATE 5

LEGEND

<u>PERIOD</u>	<u>SYMBOL</u>	<u>DESCRIPTION</u>
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mo	KEOKUK - BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: BACHELOR, AND HANNIBAL FORMATION (LIMESTONE AND SHALE)
DEVONIAN	D	SULPHUR SPRING GROUP: BUSHBERG SANDSTONE, GLEN PARK LIMESTONE, GRASSY CREEK SHALE
ORDOVICIAN	Ou	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Omk	CAPE LIMESTONE
	Ojd	JOACHIM DOLOMITE
	Osp	ST PETER SANDSTONE
	Ojc	SMITHVILLE FORMATION, POWELL DOLOMITE





APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

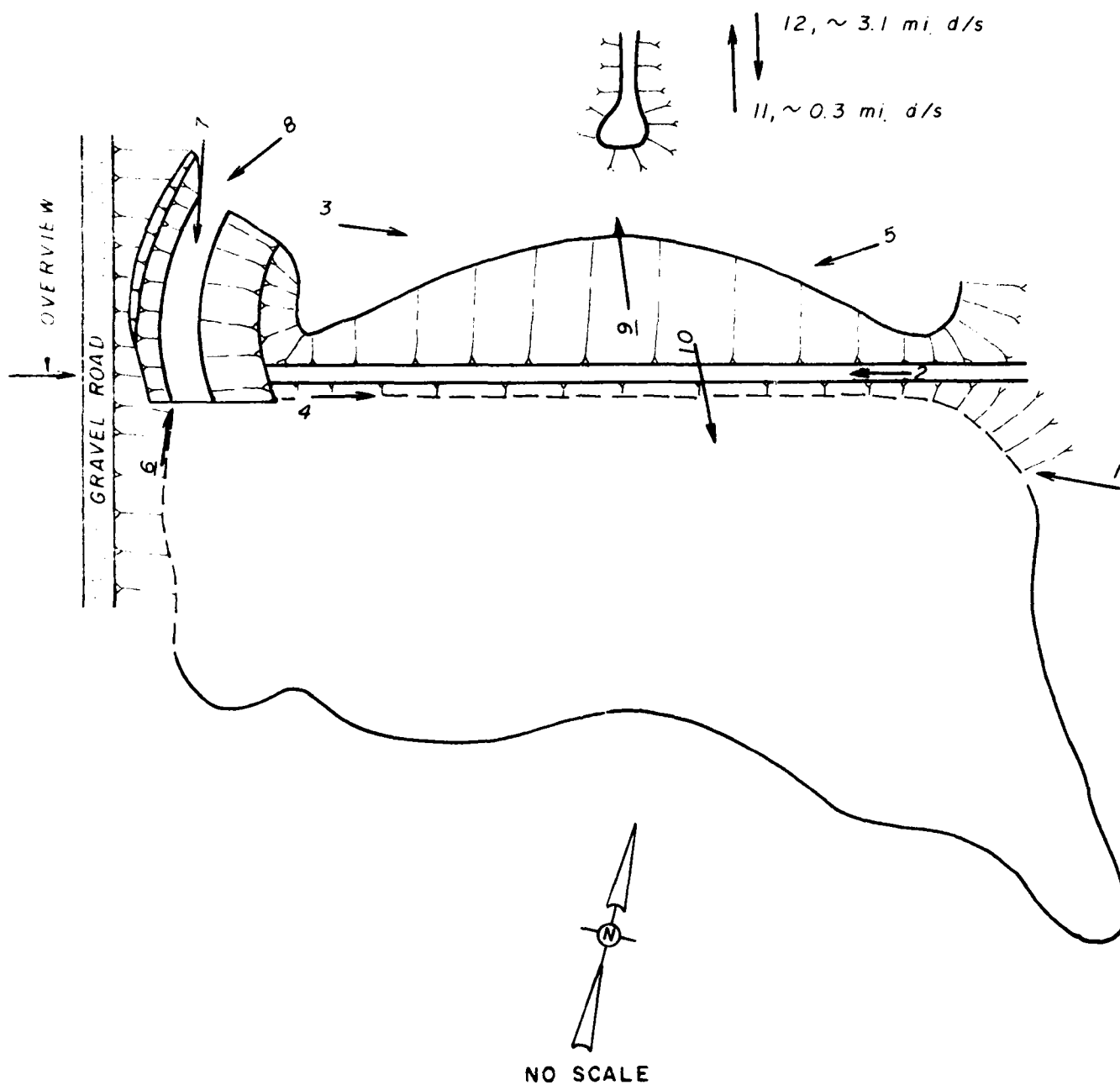


PHOTO INDEX  
FOR  
ZANDER LAKE DAM

Zander Lake Dam

Photographs

- Photo 1 - View of the upstream slope showing the wave erosion and cattails along the shoreline.
- Photo 2 - View of the top of dam showing the tall unmaintained vegetative cover.
- Photo 3 - View of the downstream slope.
- Photo 4 - Close-up view of the wave erosion, undercutting and cattails on the upstream slope.
- Photo 5 - View of a small animal burrow near the toe of the embankment.
- Photo 6 - Downstream view of the control section of the spillway showing cattails at the entrance, and small tree and tall grass in and near the crest and discharge channel area.
- Photo 7 - View of the spillway discharge channel looking towards the reservoir, showing tall grass and small tree.
- Photo 8 - View of the standing water (possibly due to quick condition) in the discharge channel of the spillway. Hay bales in the channel are seen in the background.
- Photo 9 - View of the downstream channel from the top of dam.
- Photo 10 - View of the reservoir and rim.
- Photo 11 - View of dwelling approximately 0.3 miles downstream of the dam taken from the downstream channel.

Photo 12 - View of dwelling and 2 sheds approximately 3.1 miles downstream of the dam showing the downstream channel (Little Loutre Creek) on the left side of the photo.

Zander Lake Dam



Photo 1

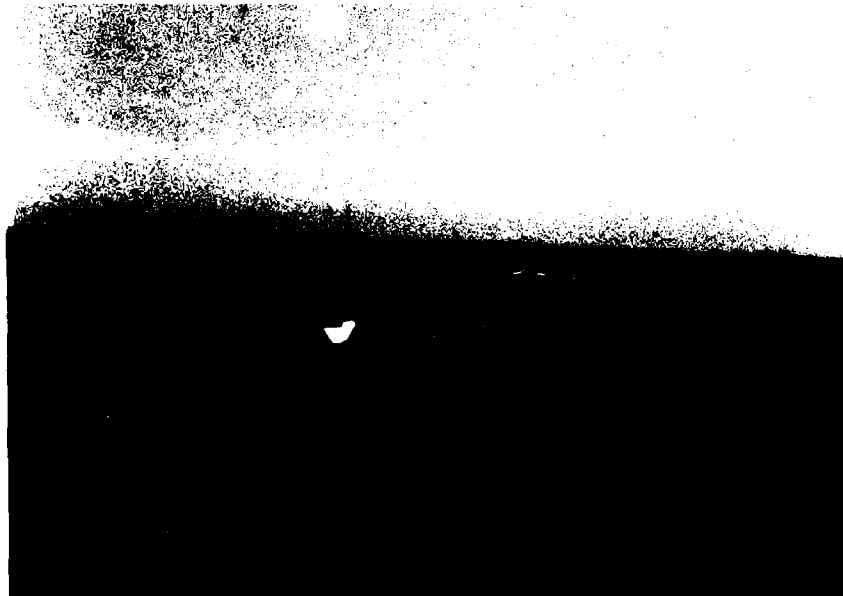


Photo 2

Zander Lake Dam



Photo 3



Photo 4

Zander Lake Dam

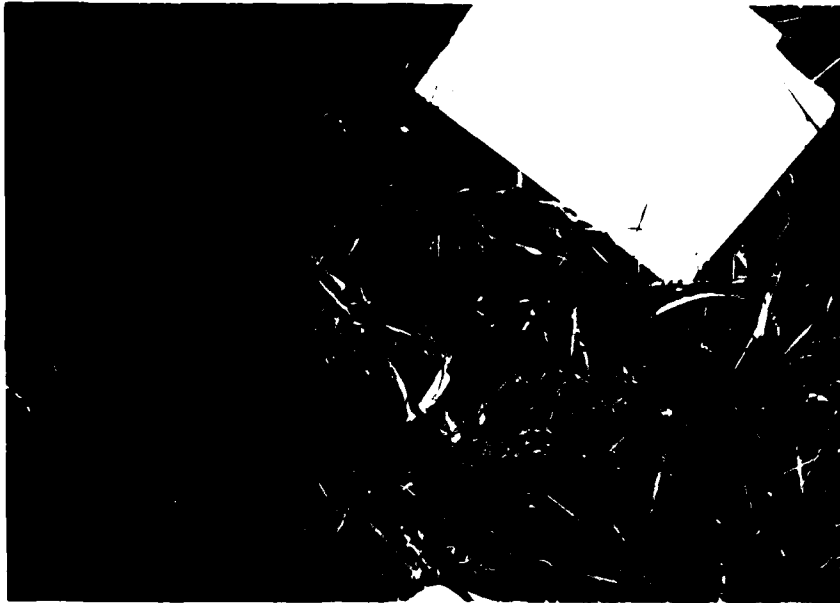


Photo 5



Photo 6



Zander Lake Dam



Photo 7



Photo 8

Zander Lake Dam



Photo 9



Photo 10

Zander Lake Dam



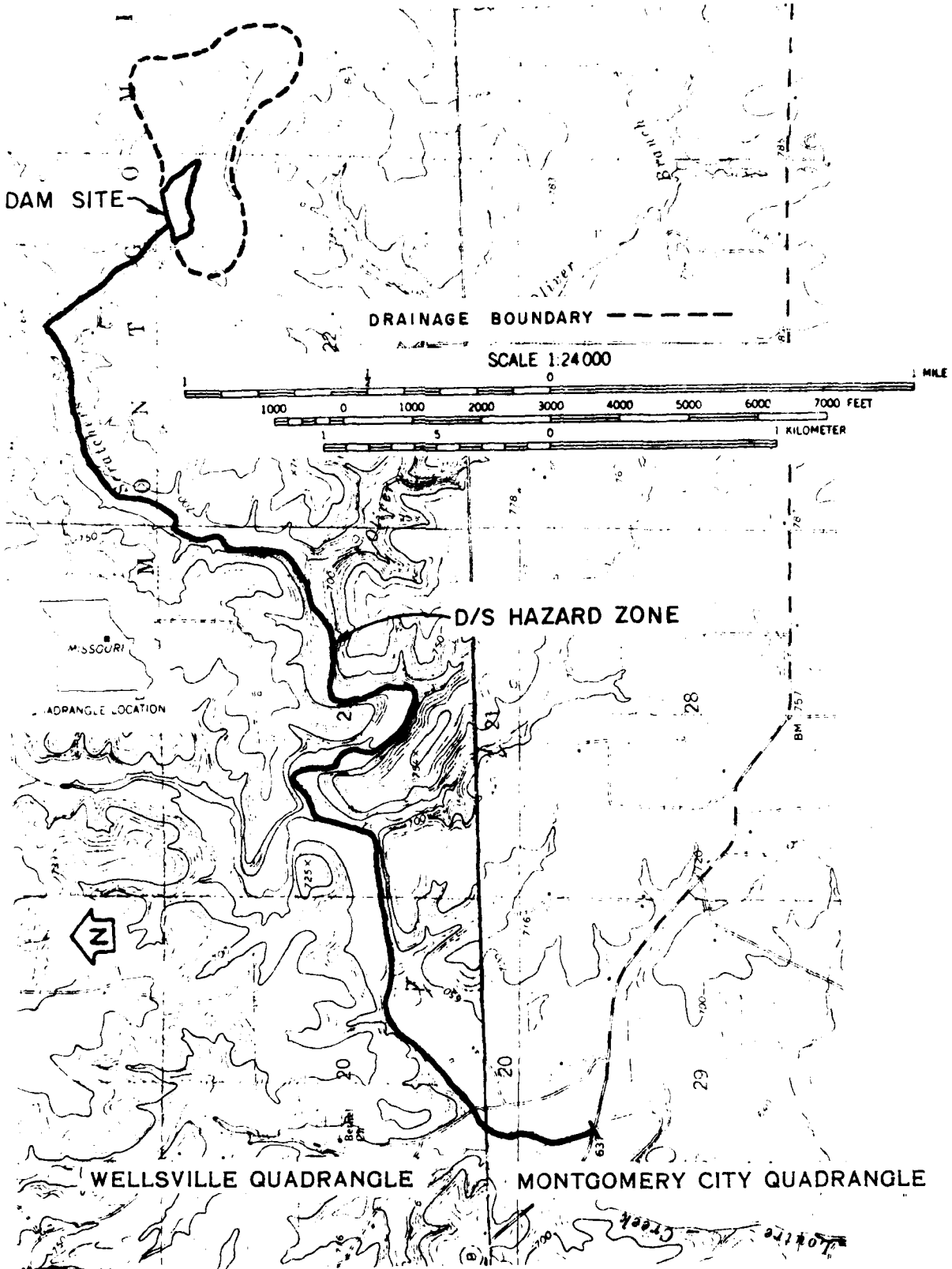
Photo 11



Photo 12

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



**ZANDER LAKE DAM (MO. 10593)  
DRAINAGE BASIN AND  
DOWNSTREAM HAZARD ZONE**

# PRC ENGINEERING CONSULTANTS, INC.

SAFETY INSPECTION - MISSOURI

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

DAM NAME: ZANDER LAKE DAM / ID NO.: 10593

JOB NO. 1263

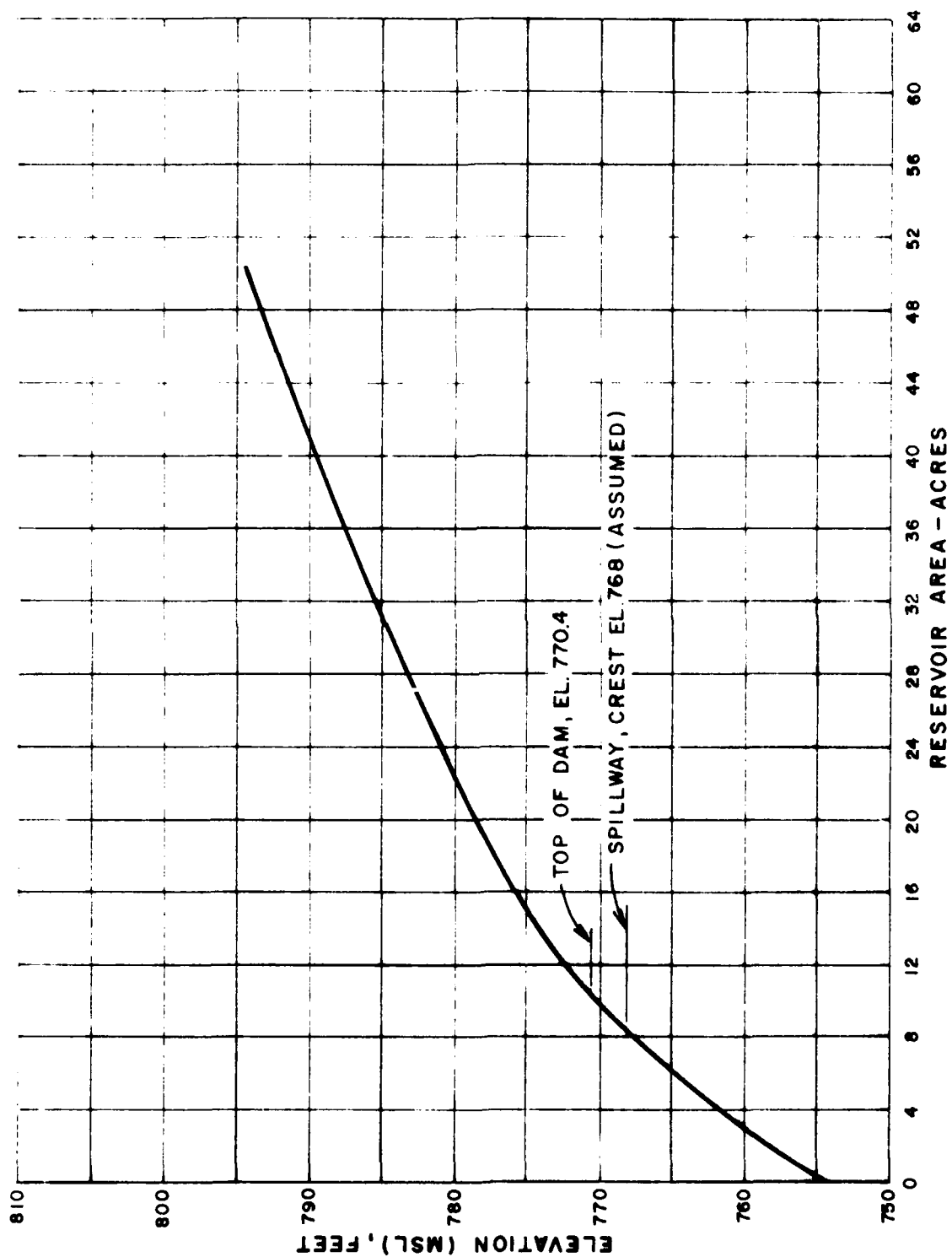
RESERVOIR ELEVATION - AREA DATA

BY FZ

DATE JUL 80

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
154	0	RESERVOIR STREAM BED
160	4.5	Interpolated
165	6.5	"
168	8.5	Spillway crest (Assumed)
170.4	10	Top of dam
175	15.0	Interpolated
180	22.0	USGS Quad. reading
185	31	Interpolated.

PLATE 2, APPENDIX B



ZANDER LAKE DAM (MO. 10593)  
RESERVOIR ELEV.- AREA CURVE

# PRC ENGINEERING CONSULTANTS, INC.

PROJECT: INSPECTION / MISSOURI

SHEET NO. 1 OF 1

PROJECT NAME: (MO 10593)

JOB NO. 1263

PROJECT HYDROGRAPH PARAMETERS

BY: KL8 DATE: 6/30

1) DRAINAGE AREA,  $A = .177$  sq. mi. = (113 acres)

2) LENGTH OF STREAM,  $L = (1.2 \times 2000' = 2400') = .455$  mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$$H_1 = 815$$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST,  $H_2 = 768$

5) ELEVATION OF CHANNEL BED AT  $0.85L$ ,  $E_{85} = 807$

6) ELEVATION OF CHANNEL BED AT  $0.10L$ ,  $E_{10} = 770$

7) AVERAGE SLOPE OF THE CHANNEL,  $S_{AVG} = (E_{85} - E_{10}) / 0.75L = \frac{807 - 770}{0.75 \times 2400} = 0.02$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3) / (H_1 - H_2)]^{0.385} = \left( \frac{11.9 \times 0.455^3}{815 - 768} \right)^{0.385} = 0.237 \text{ hr}$$

B) BY VELOCITY ESTIMATE,

$$\text{SLOPE} = 2\% \Rightarrow \text{AVG. VELOCITY} = 2.5 \text{ fps}$$

$$t_c = L / V = \frac{2400 \times \frac{1}{3600}}{2.5} = 0.27 \text{ hr}$$

$$\text{USE } t_c = 0.237$$

9) LAG TIME,  $t_L = 0.6 t_c = 0.142$

10) UNIT DURATION,  $D \leq t_L / 3 = 0.047$

$$< 0.083 \text{ hr.}$$

$$\text{USE } D = 0.083$$

11) TIME TO PEAK,  $T_p = D/2 + t_L = 0.184$

12) PEAK DISCHARGE,

$$q_p = (484 \times A) / T_p = 466 \text{ cfs}$$



# PRC ENGINEERING CONSULTANTS, INC.

SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. 1 OF 1

NAME: SANDER LAKE DAM (MO 10593) JOB NO. 1263

CURVE NUMBER DETERMINATION BY KL8 DATE 6/30

## I) SOIL GROUP

WATERSHED SOILS IN THE BASIN CONSIST OF:

PUTNAM, MEXICO  
(GR. D) (GR. D)

GROUP D SOILS SEEM TO PREDOMINATE THE BASIN. THEREFORE,  
ASSUME GROUP D SOILS FOR THE ENTIRE WATERSHED  
FOR HYDROLOGIC PURPOSES.

## II) COVER COMPLEX

ASSUMED LAND USE	ASSUMED HYDROLOGIC CONDITION	PER CENT AREA	CN (AMC II)
FOREST	FAIR	10%	79
RANGE	FAIR	90%	84

## III) CURVE NUMBER

WEIGHTED AVERAGE CN = 84 FOR AMC II

CURVE NUMBER = 93 FOR AMC II

# PRC ENGINEERING CONSULTANTS, INC.

PROJECT: WATERSHED INSPECTION / MISSOURI

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

DAM NAME: HANDER LAKE DAM (MO. 10593)

JOB NO. 1263

PROBABLE MAXIMUM PRECIPITATION

BY W.B.

DATE 6/30

## DETERMINATION OF PMP

1) Determine drainage area of the basin

$$D.A. = 113 \text{ Ac} = 0.177 \text{ Sq. mi.}$$

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi. & 24 hr. duration)

Location of centroid of basin,

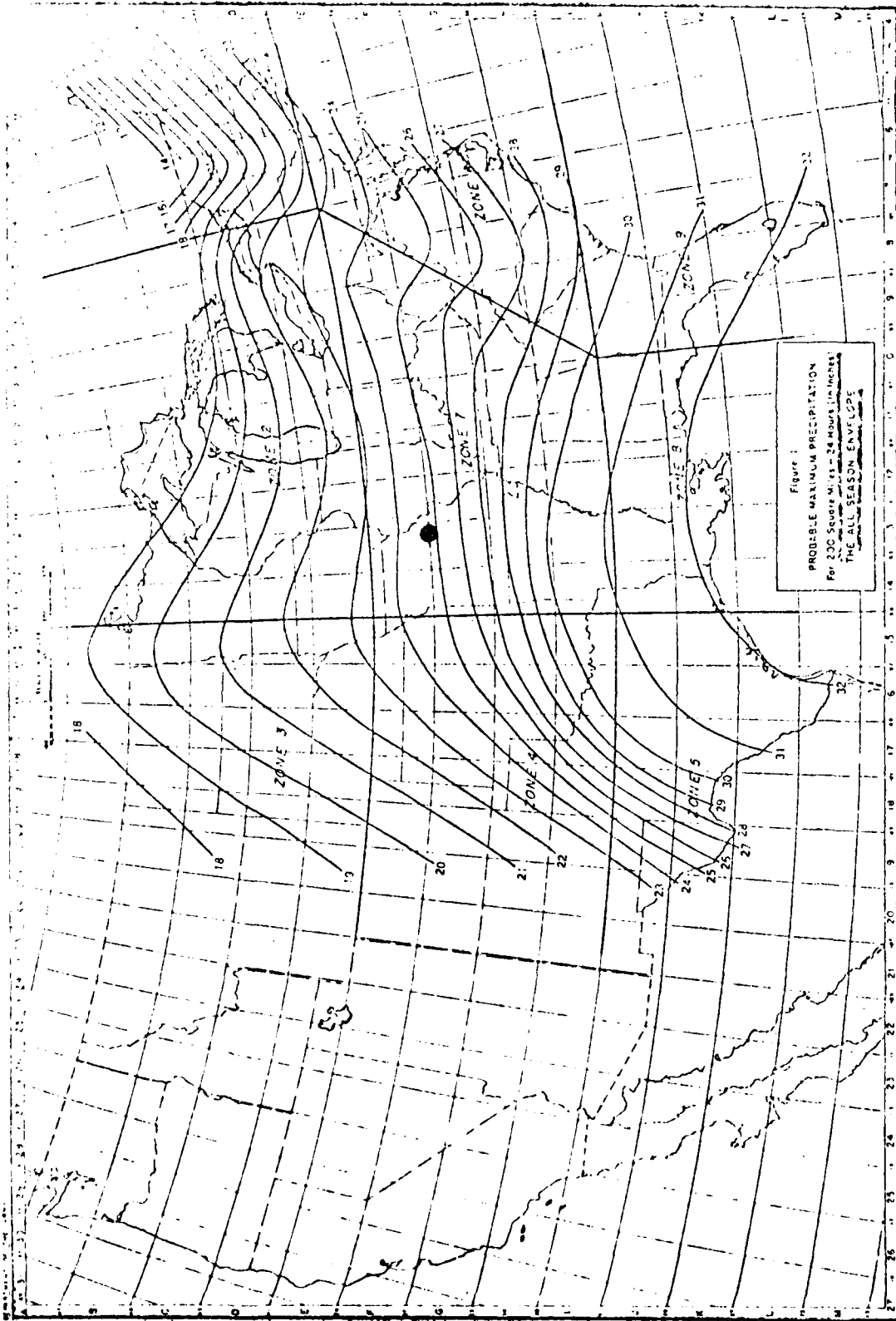
$$\text{Long.} = 91^{\circ} 33' 27'' \quad \text{Lat.} = 39^{\circ} 0' 48''$$

$$\text{PMP} = 24.8 \quad (\text{from Fig. 1, HMR 33})$$

$$\text{Zone} = 7$$

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations.  
(from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)	Rainfall Increments (Inches)	Duration of Increment (Hrs.)
6	100	24.8	24.8	6
12	120	29.8	5.0	6
24	130	32.2	2.4	12



⊕ Location of Basin Centroid  
Zander Lake Dam (MO. 10593)

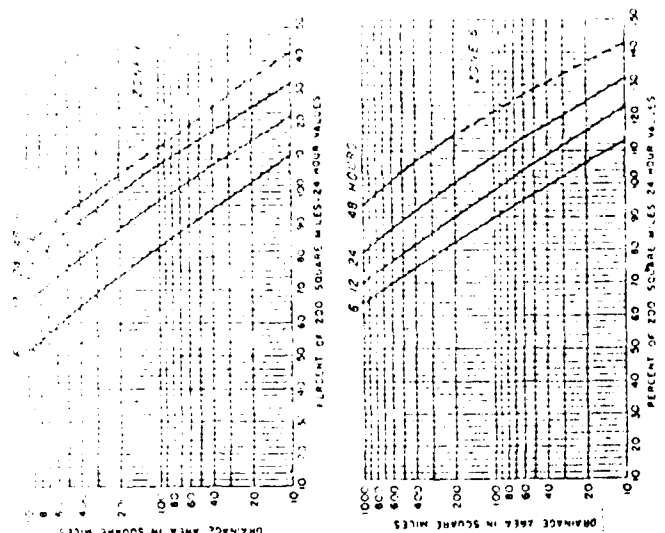
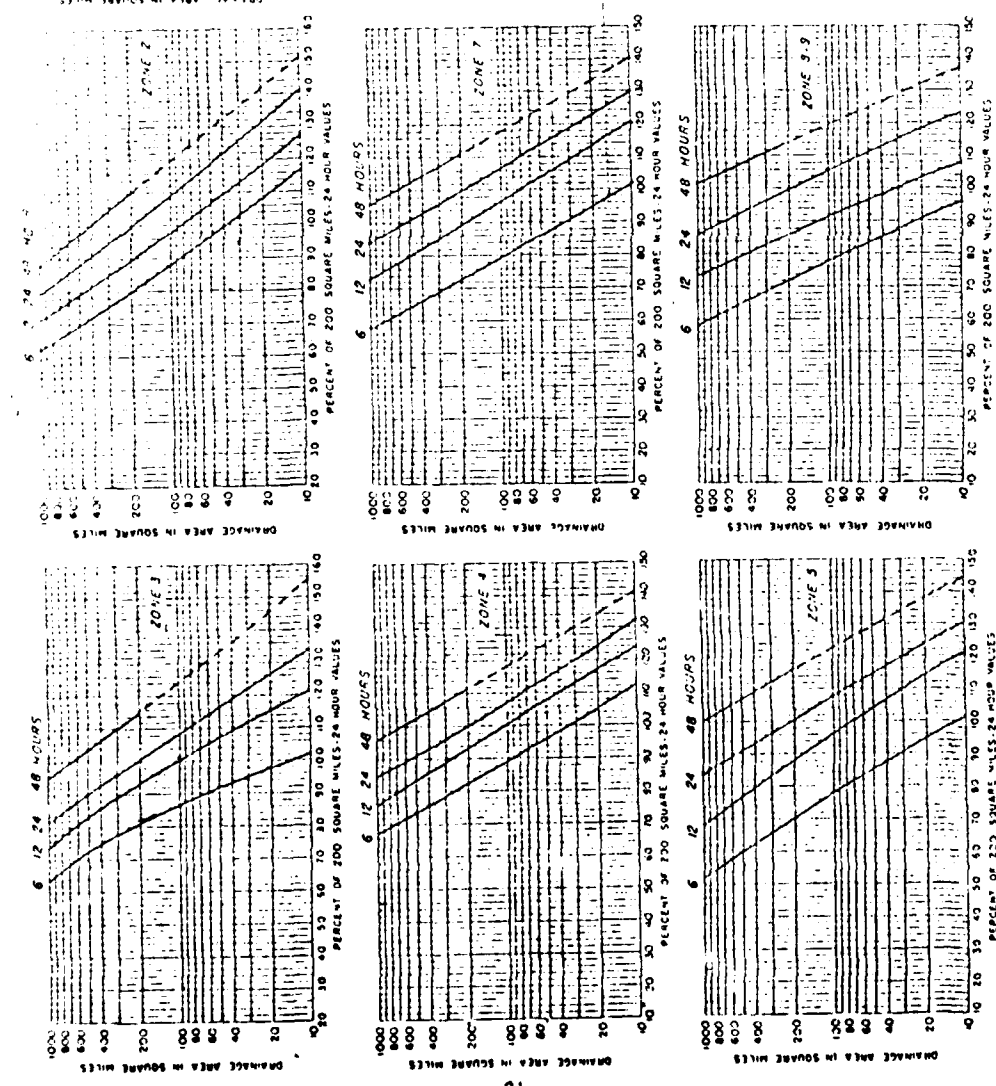


FIGURE 2  
SEASONAL VARIATION  
DEPTH-AREA-DURATION RELATIONS-IPS  
Percentage to be applied to 200 square miles  
24 hour probable maximum precipitation values  
for the all season envelope



# PAC ENGINEERING CONSULTANTS, INC.

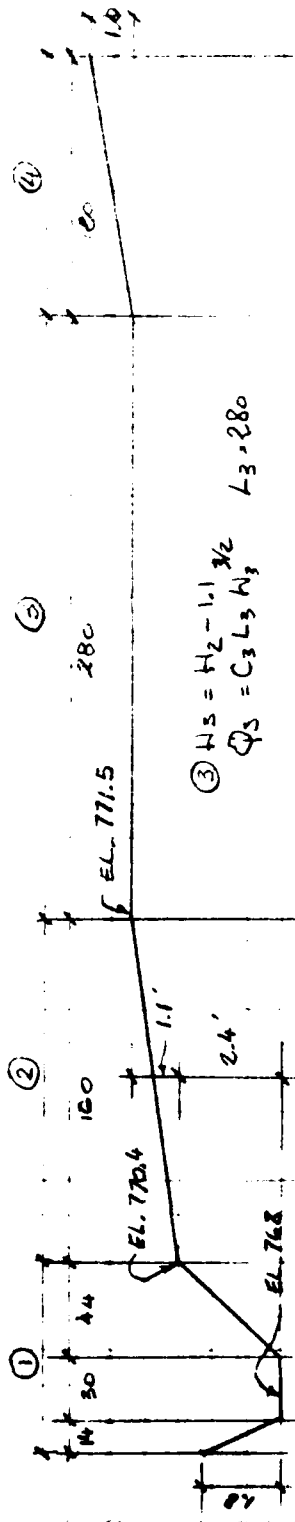
SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

DAM SAFETY INSPECTION

JOB NO. 1263

ZANDER LAKE DAM # 10593

BY PK DATE July 80



①				②				③				④								
$Y_{c1}$	$A_1$	$T_1$	$V_1$	$Q_1$	$V_1^2$	$H_1$	WSEL	$H_2$	$Y_{c2}$	$A_2$	$T_2$	$Q_2$	$H_3$	$C_3$	$Q_3$	$H_4$	$Y_{c4}$	$A_4$	$T_4$	$Q_4$
0.0	18.3	43.1	5.7	67.5	0.21	0.71	768.00													
0.5	43.1	56.1	5.0	214.0	0.38	1.38	768.71													
1.0	73.4	69.2	5.9	437.6	0.54	2.04	769.38													
1.5	88.7	74.4	6.2	549.9	0.60	2.30	770.04													
1.7	104.1	78.8	6.5	678.7	0.66	2.56	770.56	0.16	0.13	1.2	18.6	1.7								
1.9	122.6	84.3	7.0	900.8	0.76	2.96	770.96	0.56	0.45	14.6	65.2	39.2								
2.2	163.4	88	7.7	1243.5	0.93	3.53	771.53	1.13	0.90	59.4	181.5	276.7	0.03	2.86	4.2	0.03	0.02	0.03	2.9	0.0
2.6	178.2		7.9	1366.9	0.98	3.68	771.58	1.28	1.02	76.3	188.0	309.6	0.18	2.96	63.3	0.18	0.14	1.24	17.3	1.9
2.9	189.8		8.5	1581.7	1.08	3.98	771.98	1.58	1.24	109.9	160	516.6	0.48	3.02	281.2	0.48	0.38	8.9	46.1	22.0
3.1	207.4		8.7	1806.8	1.18	4.28	772.28	1.88	1.44	141.9		758.0	0.78	3.03	584.8	0.78	0.62	23.4	76.9	74.1
5.4	233.8		9.3	2162.5	1.33	4.73	772.73	2.33	1.74	189.9		1173.7	1.23	3.04	1160.4	1.23	0.98	58.1	118.1	231.2
4.0	286.6		10.2	2835.0	1.63	5.63	773.63	3.23	2.94	285.9		2168.3	2.13	3.07	2085.3	2.13	1.59	180.4	120	771.4

① $Y_{c1} < 1.8 \Rightarrow$ $A_1 = \frac{1}{2} (Y_{c1} + 30) \cdot 30$ $T_1 = 26.3 Y_{c1} + 30$	② $H_2 = H_1 - 2.4$ $Y_{c2} < 1.1 \Rightarrow Y_{c2} = \frac{4}{5} H_1$ $A_2 = 72.7 Y_{c2}$ $T_2 = 145.5 Y_{c2}$ $Y_{c2} > 1.1$ $Y_{c2} = \frac{2}{3} (H_2 + 0.48)$ $A = 180 (Y_{c2} - 0.55)$ $T = 160$	③ $H_4 = H_3$ $Y_{c4} < 1 \Rightarrow Y_{c4} = \frac{1}{3} H_4$ $A_4 = 120 (Y_{c4} + \frac{1}{3})$ $T_4 = 120$ $Y_{c4} > 1 \Rightarrow Y_{c4} = \frac{2}{3} (H_4 + \frac{1}{3})$ $A_4 = 120 (Y_{c4} - 0.5)$ $T_4 = 120$
--	--	---

# PRC ENGINEERING CONSULTANTS, INC.

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

SAFETY INSPECTION

JOB NO. 1263

ZANDER LAKE DAM

BY FE DATE JUL 80

## VERIFICATION OF CRITICAL DEPTH ASSUMPTION

$y_c$	$Q$	$y_n^*$
1.0	214	0.69
2.2	901	1.49
2.9	1582	1.97
3.4	2163	2.29

$$Q = \frac{1.49}{n} S^{1/2} \frac{A^{3/2}}{P^{4/3}}$$

$$y_m < y_c$$

Supercritical  $\rightarrow$  O.K.

$$S = \frac{2.8}{50} = 0.056$$

$$n = 0.03$$

\* NORMAL DEPTH CALCULATED FROM GIVEN CROSS SECTION DATA

BY PROGRAMMABLE CALCULATOR

# PEC ENGINEERING CONSULTANTS, INC.

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

SAFETY INSPECTION

JOB NO. 1263

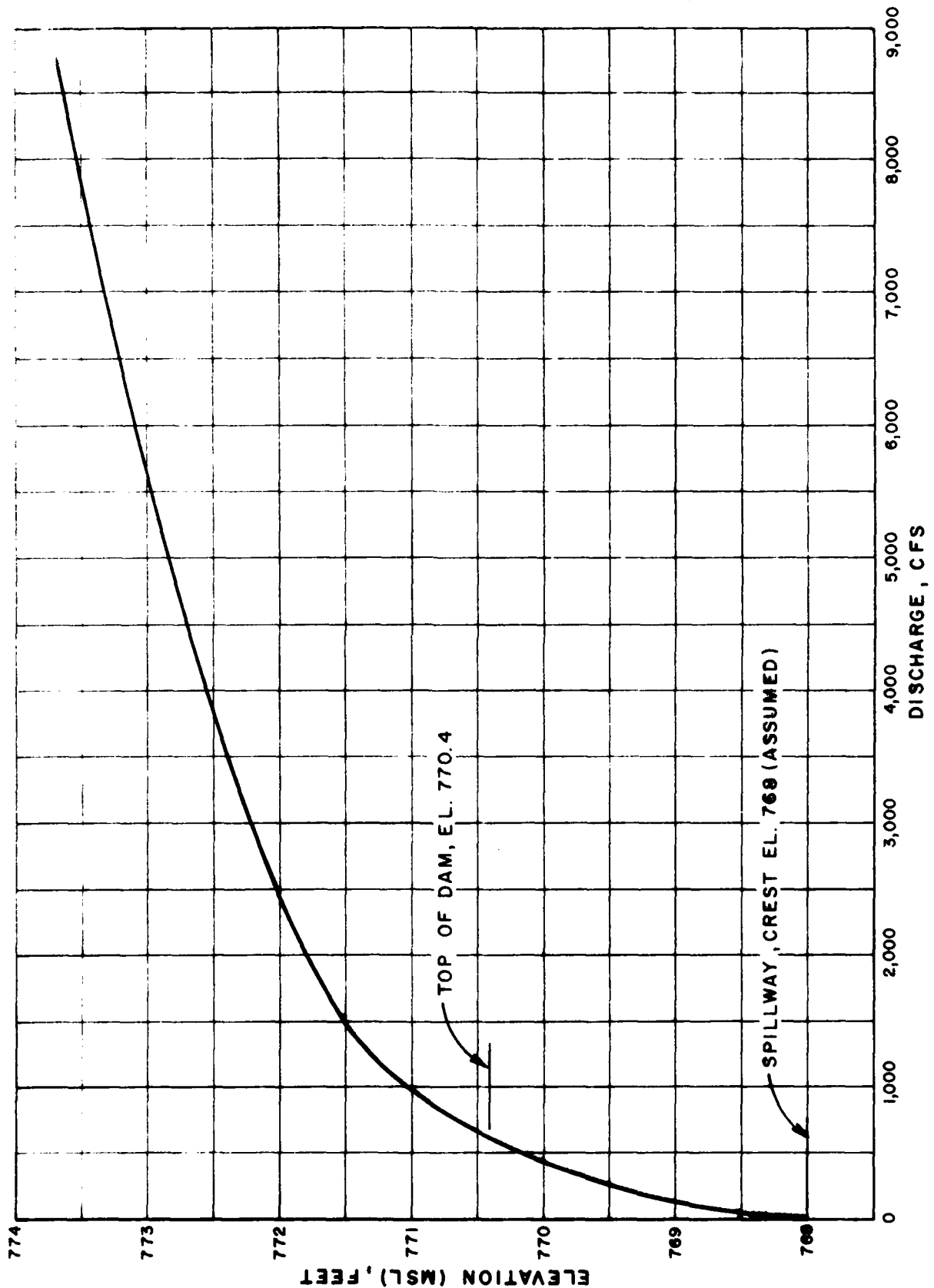
ZANDER LAKE DAM # 10599

BY FR DATE JUL 80  
K.I.P.

## Spillway and Overtop Rating Curve

WSEL	Total $\Phi$
768.00	0
768.71	68
769.38	21.4
770.04	43.8
770.30	55.0
770.56	68.0
770.96	94.0
771.53	149.4
771.68	174.2
771.98	240.2
772.28	322.3
772.73	472.8
773.63	855.0

PLATE 3, APPENDIX B



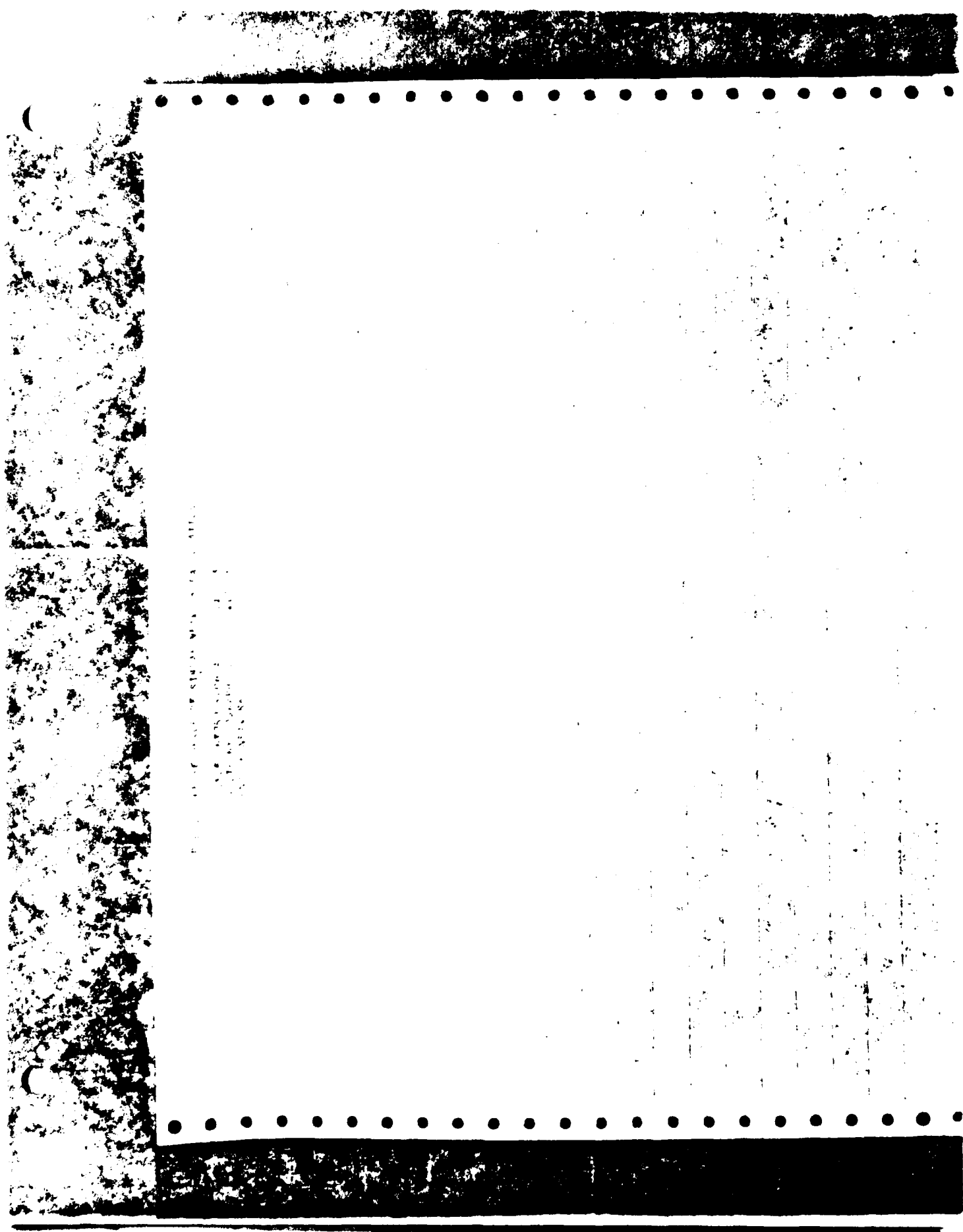
ZANDER LAKE DAM (MO. 10593)  
SPILLWAY & OVERTOP RATING CURVE



HEC1DB INPUT DATA



INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS



11. 11. 12.

[illegible]

100

```
*****  
SURFACE RUNS COMPLETION  
*****
```

## RUNOFF CALCULATIONS

ISTAN	ICOMP	RECON	ITAFE	JULY	JPRY	INAME	ISTAGE	1410
1953	Q	Q	Q	Q	Q	1	Q	Q

[illegible][illegible]

CADPT	SINER	MTER	RTOOL
TRAIN			
SING'S			
LOSS DATA			
RTION			
SYTEL			
CASTL			
ALOMX			
RTYED			

CURVE NO = 1000 DEFNS = 1000 EFFECT EN = 0.00

UNIT WJDP064APH DATA  
TCE 3470 LAGE=14

REFLECTION DATA

TIME INCREMENT TOO LARGE--INHQ IS 6Y LAG/2)

UNIT HYDROGRAPH AT END OF FELLOU COORDINATES. YLE= 0.00 HOURS. LAG= .14 VOLTS 1.00

[illegible]









PMF AND ONE-HALF PMF ROUTING



[illegible]







SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING



PEAK FLOW AND STORAGE (BASED ON PERIOD 1) - SUMMARY OF VARIOUS RATIO-RATE ECONOMIC COMPUTATIONS  
 (BASED ON 1000 TO 1000000 GALLONS PER DAY)

AREA IN SQUARE FEET (SEE SHEET 14)

RATIO 2-PLUG IN FLOWS

NO. OF PLUGS	STATION	AREA	PLUG	RATIO 1	RATIO 2	1.00
1	STATION 1	418	1	221.2	110.6	
2	STATION 2	418	2	62.600	31.300	
3	STATION 3	418	3	17.7	8.85	
4	STATION 4	418	4	4.425	2.2125	

COMPARISON OF TEST RESULTS

DATE OF TEST	ALUMINUM REINFORCING BAR	MAXIMUM STRESS IN BAR	MAXIMUM OUTSIDE DIMENSION	MAXIMUM OUTSIDE DIMENSION	DIRECTION OF STRESS	TIME OF TEST	TIME OF FAILURE
10/1/50	7/16x7/8	14,075	1.07	1.07	11.75	0.30	0.30
10/1/50	7/16x7/8	14,075	1.07	1.07	15.83	0.30	0.30

TEST VALUE  
77,493  
PL  
6000

TEST VALUE  
77,493  
PL  
6000

PERCENT OF PMF FLOOD ROUTING  
EQUAL TO SPILLWAY CAPACITY

PREVIEW OF EQUIPMENT SPECIFICATIONS FOR THE T-100

REMOVED FROM THE T-100  
PRINTED AT THE T-100  
FOR THE T-100

91-677  
90-1130

"SAFE" (SAFE POL - POL - 100)  
Z... (SAFE POL - POL - 100)  
PC... (SAFE POL - POL - 100)

[illegible]

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

[illegible]

## RUNOFF CALCULATIONS

ISTAT	ICOMP	ICOGN	ITAGE	UNIT	INAME	ISTAGE	IAUTO
0000	0	0	0	0	1	0	0

TABLE	SWAP	TRSDA	TRSPC	RATIS	ISNOS	ISAME	LOCAL
1000	1.00	1.00	1.00	0.00	0.00	0.00	0.00

PRECIP DATA			
SPOT	WS	R	RAD
04 00	100.00	812	47.0
04 00	100.00	812	47.0

	STARR	OLIVER	RIFICO	EVLAIN	DARKS	FITTON	CENTL	COSTO	AUSMAN	MILMP
LEADPI			1986	1986	1986	1987	1987	1987	1987	1987

CIRCUIT NO. 2 - \$9.00 - ETC., = - 1.00

UNIT MICROGRAPH: ATB  
IC= 0.0. LAG= .14

```

PRECISION DATA
START= 0.00  QRCSE= 0.00  PTUNE= 1.00

```

[illegible]

CUW	92-20	31-77	83	429.30
	(819.16)	795.11	23.80	1219.59)

ALL INFORMATION CONTAINED  
HEREIN IS UNCLASSIFIED

...THE PULPIT: THROUGH 3A.

	INSTA	ICOMP	MEMO	IUNIT	JUNIT	INSTR	LSTAGE	HACQ
	CLOS	DWV	BOUTINGATA	PY	FPG			
	NUTS	NSTL	L6G	A9	X	SIGRA	ISPRAT	
						-ZRC-		

[illegible][illegible]

1. The first part of the document is a list of names and titles, including "The Hon. Mr. Justice" and "The Hon. Mr. Justice".

204111	19	19	17	362	91
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DATE	TIME	TEMP.	WIND	SEA	REMARKS
1954	7.00	75°	1.4	77°	79°
1955	7.00	75°	1.4	77°	79°

CALL	SFMT	TIME	DATE	FROM	TO
		7:10	MAY 7	COUL	WYATT
		7:13	MAY 7	COUL	WYATT

[illegible]

SI MCTEJENI 30. AT TIMI 15.43 HVALS

100

100

ST. AUGUSTINE  
MO. AT TIME 15.33 HOURS

100

1. The first step is to identify the problem or question that needs to be addressed. This involves understanding the context and the specific requirements of the task.

[illegible]

1. The first part of the document is a title page. It contains the title "THE HISTORY OF THE UNITED STATES OF AMERICA" and the author's name "BY JAMES MADISON".

100

100

100

Figure 1. The effect of the concentration of the *Agrobacterium* strain on the transformation efficiency of *Agrobacterium* strain on *Arabidopsis thaliana* cells. The transformation efficiency was determined by the number of transformants per 100 cells. The data were obtained from three independent experiments. The error bars represent the standard deviation.

COMPUTATION

1. 100% OF THE TOTAL FLOW OF WATER IN THE RIVER AT THE  
STATION IS USED FOR THE PURPOSES OF THE PROJECT  
2. 100% OF THE TOTAL FLOW OF WATER IN THE RIVER AT THE  
STATION IS USED FOR THE PURPOSES OF THE PROJECT

STATION

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

100%

77 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038

DATE	LOCATION BY ADDRESS	AMOUNT PAID FOR OFFERED	MARKING ACC-CT	MAILED DATE	TERMINAL HOURS	TIME OF MAX FLOW HOURS	TIME OF FAILURE HOURS
2-1	775-11	0.30	7-0	4-9	0-7	15-45	0-30
2-1	775-11	0.30	8-0	4-9	0-7	15-45	0-30
2-1	775-11	1-00	1-0	5-0	0-0	17-05	0-00
2-1	775-11	0.11	0-0	4-9	0-7	15-45	0-00



END

DATE  
FILMED

10-81

DTIC